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Description

METHOD OF FABRICATING A STAMPER WITH MICROSTRUCTURE PATTERNS

BACKGROUND OF INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to a method for fabricating a stamper, and more particularly, to a method for fabricating a stamper without a cutting process.

[0003] 2. Description of the Prior Art

[0004] Since injection-molding fabrication has the advantages of easily molding products, being suitable for mass production, having a lower production cost, and easily molding complicated products, it has been widely applied to disk record mediums, daily commodities, consumer electronics, and motor vehicle components and has become a popular molding technology in plastic and metal processing industries. In the above-mentioned injection-mold process, the insert-mold for copying microstructure pat-

terns of the products plays an important role, and it may even affect the performance of products.

[0005] The conventional fabricating method of the insert-mold having a big size involves installing a stamper on the injection mold for serving as the insert-mold. Generally, after the pattern is formed on the surface of the stamper by the injection process, a mechanical cutting process will be performed to cut the stamper with the required size of the insert-mold. However, the prior art mechanical cutting process often causes a slight deformation or burr problem. As a result, the stamper may harm the smooth injection mold, and furthermore, the problem may cause that the injection-molding product cannot match accuracy requirements, especially when producing optical products, such as a light guide plate. Therefore, the conventional fabricating method of stampers with a mechanical cutting process may cost more fabricating time, and cannot reach the accuracy requirement of the cutting process.

[0006] Furthermore, when the stamper is applied to super-precise or micron-injection molding processes for electronic and optical products, an improved technology, electroforming process, may be used to produce the entire stamper directly for forming the precise microstructure pat-

terns on the stamper. However, the electroforming process has a problem that the size of produced stamper is limited with the electroforming equipment and the size of produced stamper is larger than the required size. Generally speaking, the produced stamper has the same size as the substrate carrying the produced stamper of the electroforming equipment, thus the redundant portion of the electroformed stamper has to be cut for making the stamper match the injection mold. Therefore, the fabrication of stampers with the electroforming process still has the problem of deformation and burr resulting from the cutting process.

SUMMARY OF INVENTION

[0007] It is therefore a primary objective of the claimed invention to provide a method of fabricating a stamper that uses a growth stop wall in an electroforming process to solve the above-mentioned problem.

[0008] According to the claimed invention, the method of fabricating a stamper with microstructure patterns comprises providing a substrate, forming a first patterned layer on the substrate, which has a pattern complementary to the microstructure patterns of the predetermined stamper, forming a second patterned layer on the substrate for

defining an edge of the stamper, and performing an electroforming process by taking the second patterned layer as a growth stop wall so as to form at least one predetermined stamper.

[0009] It is an advantage of the claimed invention that the second patterned layer serving as a growth stop wall is formed on the substrate before the electroforming process, so that the electroformed stamper can have a predetermined size fitting the injection mold. As a result, the electroformed stamper does not need to be further fabricated with a mechanical cutting process, and the problem of deformation and burr resulting from the conventional mechanical cutting process can be avoided.

[0010] These and other objectives of the claimed invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment, which is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0011] Figs.1-7 are schematic diagrams of a first embodiment of fabricating a stamper according to the present invention.

[0012] Fig.8 is a schematic diagram of a third embodiment of fabricating a stamper according to the present invention.

DETAILED DESCRIPTION

[0013] Please refer to Figs.1-7, Figs.1-7 are schematic diagrams of the first embodiment of fabricating a stamper according to the present invention. As shown in Fig.1, a substrate 10 is provided, which may be a clean glass substrate or another isolating substrate. Then, a photoresist layer 12 is coated on the substrate 10, and a photolithography process is performed to transfer a designed pattern to the photoresist layer 12. After a development process, a first patterned layer 12 as shown in Fig.2 is formed. The pattern of the first patterned layer 12 is complementary to the microstructure patterns of the predetermined stamper. In this embodiment, the first patterned layer 12" is formed with a photosensitive material, which is not limited to a positive photoresist material or a negative photoresist material.

[0014] Referring to Fig.3, a thin seed layer 14 is formed on the surface of the substrate 10 and the first patterned layer 12, which closely and precisely covers the first patterned layer 12 and the substrate 10, so that the seed layer 14 has a pattern approximately the same as the pattern of the first patterned layer 12. The main functionality of the seed layer 14 is to adsorb electroforming metal materials.

Accordingly, the thickness of the seed layer 14 depends on the requirements of the fabrication process, wherein the thickness of the seed layer 14 can be designed with the unit of nanometer (nm). For accomplishing the function of the seed layer 14, preferably, its material is a conductive metal, such as nickel or silver. The seed layer 14 is formed by the way of sputtering, evaporation, or electroless-plating processes. Furthermore, nonmetallic conductive materials, such as a carbon film, can also be used as the seed layer 14.

[0015] Please refer to Fig.4, after forming the seed layer 14, a second patterned layer 16 comprising isolating material is formed on the substrate 10. In this embodiment, the second patterned layer 16 is a photosensitive material, such as a positive photoresist material or negative photoresist material. The pattern of the second patterned layer 16 is defined by a photolithography process that exposes a photomask with a specific pattern and a development process so as to transfer the specific pattern onto the second patterned layer 16. It should be noted that the second patterned layer 16 of the present invention serves as a growth stop wall during the electroforming process, and therefore the pattern of the second patterned layer 16

defines the size and edge of the predetermined stamper. As a result, the second patterned layer 16 is thick and ranges from hundreds to thousands of micrometers (μm), depending on the fabricating process, provided that the second patterned layer 16 is thicker than the predetermined stamper.

[0016] Please refer to Fig.5. Fig.5 is a top view of the substrate 10, the second patterned layer 16, and the seed layer 14 shown in Fig.4. Since the first patterned layer 12" is used for forming the microstructure patterns of the stamper, and the second patterned layer 16 is used to define the edge of the stamper, both of the patterns of the first and second patterned layers 12, 16 are staggered on the surface of the substrate 10, which means the second patterned layer 16 does not overlap the first patterned layer 12. As shown in Fig.5, a portion of the seed layer 14 covers the surface of the first patterned layer 12protruding from the substrate 10, and the second patterned layer 16 surrounds the first patterned layer 12.

[0017] Then, referring to Fig.6, an electroforming process is performed to make metal materials adsorbed and grow along the surface of the seed layer 14, but not adsorbed on the surface of the isolating second patterned layer 16. There-

fore, two predetermined stampers 18a and 18b are formed on the substrate 10. As in the above description, the electroformed stampers 18a and 18b have to be thinner than the second patterned layer 16 so that the second patterned layer 16 can have the function of being a growth stop wall in order to limit the sizes of the stampers 18a and 18b inside the area surrounded by the second patterned layer 16. Accordingly, the electroformed stampers 18a and 18b have fixed sizes and do not need to sustain a further cutting process or an extra fabricating process.

[0018] Finally, as shown in Fig.7, a releasing process is performed to make the stampers 18a and 18b release from the substrate 10, the second patterned layer 16, and the first patterned layer 12 so as to produce complete stampers 18a and 18b that do not need to be further cut and are capable of being directly installed in injection molds as insert-molds. In addition, if the material of the seed layer 14 is as same as the material of the stampers 18a and 18b, for example, both of the materials of the seed layer 14 and the stampers 18a and 18b are nickel, the seed layer 14 on the surface of the stampers 18a and 18b does not have to be removed. Instead, the seed layer 14

can be kept on the released stampers 18a and 18b and be taken as mold-inserts together. On the other hand, when the material of the seed layer 14 is different from that of the stampers 18a and 18b, the seed layer 14 has to be removed from the surface of the stampers 18a and 18b during the releasing process.

[0019] In the second embodiment of the present invention, the first patterned layer and the second patterned layer are non-photosensitive materials. Taking the first patterned layer as an example, the formation process may comprise forming a non-photosensitive material layer and a photoresist layer on the substrate sequentially, performing a photolithography process to transfer a pattern to the photoresist layer, then performing a development process, taking the patterned photoresist layer as an etching mask to etch the non-photosensitive material layer, and finally, removing the photoresist layer so as to form the first patterned layer. The formation process of the second patterned layer with a non-photosensitive material may be similar to the above-mentioned formation process of the first patterned layer, and therefore no extraneous description will be provided herein.

[0020] Please refer to Fig.8, which is a schematic diagram of a

third embodiment of fabricating a stamper according to the present invention. In the third embodiment of the present invention, the seed layer 32 is formed between the substrate 30 and the first patterned layer 34. Accordingly, the seed layer 32 is formed on the surface of the substrate 10 before the first patterned layer 34, and then the first patterned layer 34 and the second patterned layer 36 are formed on the seed layer 32. It should be noted that since the first patterned layer 34 does not overlap the second patterned layer 36, the sequence of the formation of the first and second patterned layers 34, 36 is not limited. Furthermore, the first and second patterned layers 34, 36 may be formed with the same material layer. For example, when the first and the second patterned layer 34, 36 are formed with the same material layer, several patterned photoresist layers may be used to etch a non-photosensitive material layer to form the first and the second patterned layers 34, 36 with different thickness because the second patterned layer 36 has to be thicker than the stamper 38a, 38b and the first patterned layer 34 has to be thinner than the stampers 38a, 38b. On the other hand, in order to gain a better performance of the electroforming process, the first patterned layer 34 can be

formed with conductive materials selectively for ensuring the surfaces of the stampers 38a, 38b have microstructure patterns precisely close to the first patterned layer 34.

[0021] In the fourth embodiment of the present invention, a conductive substrate is used. And the first patterned layer for defining the microstructure patterns and the second patterned layer for defining the edge of the stamper are formed on the conductive substrate. Then, the second patterned layer is taken as a growth stop wall to perform an electroforming process to form stampers. Similarly, the first patterned layer can be formed with conductive materials selectively in order to improve the electroforming performance.

[0022] In contrast to the prior art, the present invention employs two photolithography processes and an electroforming process to fabricate the stampers having predetermined shapes without a further cutting process. The main theory of the present invention takes the second patterned layer formed with isolating material as a growth stop wall when electroforming the stampers. Therefore, the produced stampers can have predetermined shapes and sizes. Although the first and third embodiments both introduce

the present invention method by fabricating two rectangular stampers simultaneously, the amount and shape of stampers that can be produced through a single electroforming process is not limited by those embodiments. Adopting the present invention to produce stampers can avoid the problems of deformation and burr caused by conventional mechanical cutting process, and can produce stampers with accurate sizes. Accordingly, the fabrication time and cost can be saved.

[0023] Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.